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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/891,192	06/26/2001	Shigeo Irie	60188-419	9324

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EXAMINER
MOHAMEDULLA, SALEHA R

ART UNIT	PAPER NUMBER
1756	8

DATE MAILED: 07/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/891,192	IRIE, SHIGEO	
	Examiner	Art Unit	
	Saleha R. Mohamedulla	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 March 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) *13-21* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-12* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claims 1-21 are pending.

Election/Restriction

1. Claims 13-21 are withdrawn from further consideration by the Examiner, 37 CFR 1.142(b) as being drawn to a non-elected invention. Election was made without traverse in Paper No. 5. Claims 1-12 are considered by the Examiner.

Specification

1. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

2. The disclosure is objected to because of the following informalities: The disclosure includes numerous sentences written in first person. For example, on page 3, sentences begin with "I found" and "I carried out." The Examiner suggests re-writing the sentences in third person to make the specification more cohesive.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 5 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over US# 6,074,804 to Endo et al. in view of US# 4,764,247 to Leveriza et al.

Endo teaches depositing a resist film on a substrate and exposing the resist in a pattern by irradiating the resist film with KrF excimer laser using a mask having a desired shape (col. 10, lines 49-56). Endo also teaches that pattern exposure can occur using extreme ultra-violet light in vacuum instead of KrF excimer laser (col. 11, lines 54-64). Endo teaches that the extreme ultra-violet light exposure can be performed without a mask (col. 11, lines 45-55), but does not preclude a mask from being used. Endo also teaches that the resist can be made out of chemically amplified resist material (col. 19, lines 15-25). Therefore, Endo teaches claim 1, 5 and 9 limitations drawn to forming a resist film out of a chemically amplified resist material on a substrate and exposing the resist film to extreme ultraviolet radiation through a photomask in vacuum.

Endo then teaches that the substrate is subjected to a bake for 120 seconds (col. 10, lines 55-60). Since the bake occurs after exposure, the bake is a post-exposure bake. Then, Endo teaches that the substrate is heated and a silylation agent is supplied to the surface of the resist film (col. 10, line 65 – col. 11, line 5). Thus, a silylated layer is formed on the exposed portions of the resist but not on the unexposed portions of the resist (col. 11, lines 5-15). Then, the resist film is dry-etched using the silylated layer as a mask with a dry developer, thereby removing the unexposed portions of the resist film to form a resist pattern (col. 11, lines 15-23). Therefore, Endo teaches claim 5 and 9 limitations drawn to post-exposure baking the resist film and claim 1 and 5 limitations drawn to developing the exposed resist film to define a resist pattern on the

substrate. Endo also teaches claim 9 limitations drawn to forming a silylated layer selectively on the surface of the post-baked film and dry-developing the film using the silylated layer as a mask to define a resist pattern.

Endo teaches that the silylation agent is supplied to the surface of the resist film by putting the agent in a gas phase through bubbling with a nitrogen gas (col. 11, lines 1-5). Therefore, the agent is supplied in a vacuum. Endo also teaches that the dry developer that is used to dry etch by using the silylated layer as a mask is the TCP9400 manufactured by Lam RESEARCH® (col. 11, lines 15-18), which is a vacuum chamber etching apparatus. Therefore, Endo also teaches claim 9 limitations drawn to forming the silylated layer and dry-developing the resist in vacuum without subjecting the resist to air.

Endo does not teach pre-baking the resist film or pre-baking and post-baking the film in vacuum.

Leveriza teaches fabricating improved semiconductor devices having photoresist materials containing silicon or silyl groups (Abstract). Leveriza teaches a resist patterning process where a resist is coated on a substrate and pre-baked in a vacuum oven (col. 5, lines 60-65). Leveriza also teaches that the resist is exposed and developed. Leveriza teaches that the resist is also post-baked in vacuum (col. 6, lines 15-20). Therefore, Leveriza teaches claim 1, 5 and 9 limitations drawn to pre-baking the resist in a vacuum and post-baking the resist in a vacuum.

The references are analogous art as they are drawn to silicon or silyl group containing resists used to pattern semiconductor devices. It would have been obvious to one of ordinary skill in the art to pre-bake the resist of Endo in vacuum as Leveriza teaches that this process

removes solvent and enhances adhesion (col. 5, lines 60-61). It would have been obvious to one of ordinary skill in the art to post-bake the resist of Endo in vacuum as Leveriza teaches this improves adhesion to the substrate (col. 6, lines 15-16). One of ordinary skill in the art would reasonably expect that the adhesion would improve upon pre- and post-baking in vacuum as the resist materials in both Endo and Leveriza have similar structures and contain silyl groups.

5. Claims 2, 6 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over US# 6,074,804 to Endo et al. in view of US# 4,764,247 to Leveriza et al. as applied to claims 1, 5 and 9 above, and further in view of US# 6,245,491 to Shi.

Endo in view of Leveriza teaches the limitations discussed above, but does not teach that the pre-baking step comprises heating the resist while irradiating the resist with radiation having too long a wavelength to sensitize the resist film.

Shi teaches a post exposure baking process to minimize acid diffusion induced critical dimension change in chemically amplified resists. Shi teaches thermally heating a photoresist layer (already exposed to deep ultraviolet radiation) while simultaneously exposing the resist to infrared radiation (claim 4). The chemically amplified resist is sensitive to deep ultraviolet radiation, which causes generation of acids in the exposed regions of the resist (col. 3, lines 1-5). Infrared radiation has wavelengths too long to generate acids in resists that are sensitive to deep ultraviolet radiation, as well as the shorter-wavelength extreme ultraviolet radiation of Endo. Shi teaches that the infrared radiation enhances the chemical reaction rate by exciting carbon-oxygen bonds (col. 3, lines 23-60). Therefore, Shi teaches that the infrared radiation is used to enhance the chemical reaction rate of the acids on the bonds. The infrared radiation does not generate the

acids; this is accomplished by the deep ultraviolet radiation, therefore, the infrared radiation is radiation having too long a wavelength to sensitize the resist film.

The references are analogous art as they are drawn to semiconductor exposure methods and chemically amplified resists. It would have been obvious to one of ordinary skill in the art to simultaneously heat and irradiate the resist of Endo in view of Leveriza as described in Shi in order to reduce the time for reaction and acid diffusion, which will then suppress critical dimension change (col. 4, lines 1-5). One of ordinary skill in the art would want to suppress critical dimension change in order to form sharply resolved and dense integrated circuit features. One of ordinary skill in the art would have a reasonable expectation of success in simultaneously heating and irradiating the resist in a pre-exposure bake, instead of the post-exposure bake of Shi, because Shi teaches that the infrared radiation decreases the reaction activation energy barrier (Abstract) by exciting the carbon-oxygen bonds. One of ordinary skill in the art would reasonable expect that the bonds would get excited before exposure and that reaction time would still decrease because upon exposure, the generated acids would react with already excited bonds.

6. Claims 3, 7 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over US# 6,074,804 to Endo et al. in view of US# 4,764,247 to Leveriza et al. and further in view of US# 6,368,776 to Harada et al.

Endo in view of Leveriza teaches the limitations of claims 1, 5 and 9 as discussed above in paragraph 4, but does not teach the additional limitations in claims 3, 7 and 11 drawn to the processing chambers and transportation between processing chambers.

Harada teaches a treatment apparatus. Harada teaches that a resist coating unit and a development unit are included in a first treatment unit group (col. 5, lines 49-54). In a third treatment unit group, a pre-baking unit and a post-baking unit are included (col. 5, lines 59-66). Harada also teaches exposing a substrate in an exposing unit (col. 1, lines 30-35). Harada also teaches that clean air is used in the resist coating unit (col. 7, lines 33-35). Harada also teaches applying resist in the resist coating unit and also employing the prebaking and development units (col. 10, lines 45-50). Therefore, Harada teaches the limitations in claims 3, 7 and 11 drawn to forming a resist film in a first processing chamber (first treatment unit group) filled with air and pre-baking the film in a second processing chamber (third treatment unit group). Endo in view of Leveriza teaches that the pre-baking, exposing and post-baking occur in a vacuum. Harada also teaches the limitations drawn to transporting the substrate to a third processing chamber (an exposing unit) for exposing (col. 1, lines 30-35). Because Harada teaches developing and that the development unit is in the first treatment group, Harada teaches the claim limitations drawn to transporting the film to the first process chamber and developing the film in the first process chamber. Because Harada teaches that the post-baking and pre-baking units are in the third treatment unit group, Harada teaches claim 7 and 11 limitations drawn to transporting the film to the second processing chamber and post-baking the film in the second processing chamber. Endo in view of Leveriza teaches the claim 11 limitations drawn to the fourth processing chamber filled with a vacuum for forming the silylated layer, because Endo teaches that the silylation agent is supplied to the surface of the resist film by putting the agent in a gas phase through bubbling with a nitrogen gas (col. 11, lines 1-5). Endo also teaches that the dry developer that is used to dry etch by using the silylated layer as a mask is the TCP9400

manufactured by Lam RESEARCH® (col. 11, lines 15-18), therefore, Endo in view of Leveriza also teaches a fifth processing chamber filled with a vacuum for dry-development.

The references are analogous art as they are drawn to resist processes including coating, baking, exposing and developing the resist. It would be obvious to one of ordinary skill in the art to use the apparatus and method of Harada where coating and developing occur in the same chamber and pre-and post-baking occur in the same chamber as Harada teaches that this type of apparatus and process is conventionally used and performed in the art (col. 1, lines 15-40 and col. 2, lines 10-20).

7. Claims 4, 8 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over US# 6,074,804 to Endo et al. in view of US# 4,764,247 to Leveriza et al. in further view of US# 6,368,776 to Harada et al. as applied to claims 3, 7 and 11 above, and further in view of US# 6,245,491 to Shi.

Endo in view of Leveriza in further view of Harada teaches the limitations discussed above, but does not teach that the pre-baking step comprises heating the resist while irradiating the resist with radiation having too long a wavelength to sensitize the resist film.

Shi teaches a post exposure baking process to minimize acid diffusion induced critical dimension change in chemically amplified resists. Shi teaches thermally heating a photoresist layer (already exposed to deep ultraviolet radiation) while simultaneously exposing the resist to infrared radiation (claim 4). The chemically amplified resist is sensitive to deep ultraviolet radiation, which causes generation of acids in the exposed regions of the resist (col. 3, lines 1-5). Infrared radiation has wavelengths too long to generate acids in resists that are sensitive to deep

ultraviolet radiation, as well as the shorter-wavelength extreme ultraviolet radiation of Endo. Shi teaches that the infrared radiation enhances the chemical reaction rate by exciting carbon-oxygen bonds (col. 3, lines 23-60). Therefore, Shi teaches that the infrared radiation is used to enhance the chemical reaction rate of the acids on the bonds. The infrared radiation does not generate the acids; this is accomplished by the deep ultraviolet radiation, therefore, the infrared radiation is radiation having too long a wavelength to sensitize the resist film.

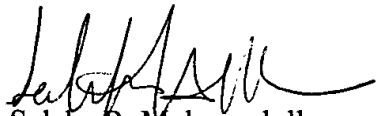
The references are analogous art as they are drawn to semiconductor exposure methods and chemically amplified resists. It would have been obvious to one of ordinary skill in the art to simultaneously heat and irradiate the resist of Endo in view of Leveriza in further view of Harada as described in Shi in order to reduce the time for reaction and acid diffusion, which will then suppress critical dimension change (col. 4, lines 1-5). One of ordinary skill in the art would want to suppress critical dimension change in order to form sharply resolved and dense integrated circuit features. One of ordinary skill in the art would have a reasonable expectation of success in simultaneously heating and irradiating the resist in a pre-exposure bake, instead of the post-exposure bake of Shi, because Shi teaches that the infrared radiation decreases the reaction activation energy barrier (Abstract) by exciting the carbon-oxygen bonds. One of ordinary skill in the art would reasonable expect that the bonds would get excited before exposure and that reaction time would still decrease because upon exposure, the generated acids would react with already excited bonds.

Citation of Relevant Art

8. The Lam RESEARCH® web page titled "TCP® 9400DFM – Silicon Etch" is cited to show a picture and description of the apparatus.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Saleha Mohamedulla whose telephone number is (703) 308-1260. The Examiner can normally be reached Monday-Friday, from 8:00 AM to 4:30 PM. If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's supervisor, Mark Huff, can be reached on (703) 308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9310. The After Final fax phone number is (703) 872-9311. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.



Saleha R. Mohamedulla
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July 23, 2003